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Research Article

# A Study on Blood Lactate Removal Among the Football Players

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**Abstract:**
The purpose of the study was to compare the blood lactate removal between active and passive recovery modes. Ten (10) under-17 national-level football players were purposively selected to fulfill the study. Participants performed a treadmill run at 90% intensity followed by either a 5-minute active or passive recovery mode. Active recovery resulted in significantly greater lactate reduction after 5 minutes (4.32 ± 2.1 mmol/L decrease) compared to passive rest (2.27 ± 1.11 mmol/L). The rapid early clearance with activity indicates better blood circulation and lactate metabolism. In addition, the difference was insignificant after 10 minutes of facilitation of both recovery modes. This study concluded that active recovery provides transient metabolic benefits optimizing lactate reduction rate for a short period. However, more research needed on durations and subsequent performance impacts will reveal ideal practical applications for intermittent, high-intensity sports.
Keywords: Active Recovery, Junior Football, Lactate Reduction, Passive Recovery

## 1. INTRODUCTION

The removal of accumulated lactate after high-intensity exercise could be an important determinant of performance in team sports like football. This ability to remove accumulated lactate during the recovery period provides insight into a player's metabolic function (Broskey et al., 2020). Faster lactate clearance rates indicate better recovery after intensive bouts of activity (Brini et al., 2020). Therefore, a better understanding of the lactate removal mechanism could have strong practical implications for football training programs concerning recovery periodization (Dimkpa et al., 2023).

Several studies have already investigated post-exercise lactate removal dynamics across various games and sports. Sañudo et al. (2020) studied blood lactate clearance during active recovery after intense running. 10 moderately trained males performed 5-min running bouts at 90% of maximal oxygen uptake, followed by active recovery at different intensities. It was found that active recovery at 80-100% of the lactate threshold cleared lactate faster than lower intensities or passive recovery (Sañudo et al., 2020). Gervasi et al. (2023) have compared active and passive recovery modes on performance in repeated Wingate anaerobic cycling tests. 12 male athletes did a 15sec Wingate test, 15sec recovery, then 30sec Wingate test. They Gervasi et al. (2023) concluded that a short durational (15s) passive recovery allows better restoration of performance capacity in between maximal sprints. Another interesting study Xiao et al. (2023) showed that active recovery can also be effective for the swimmers. In that study 9 elite swimmers performed (8 x 25m) sprints with 45s recovery, followed by a 50m sprint later. Active recovery was at 50% -60% of their lactate threshold level. Further, they recommended passive recovery for maintaining performance with short rest intervals, despite having slower lactate clearance. Plumb (2024) on their study examined commonly applied lactate recovery methods in 36 football players. After a maximal run, active recovery reduced lactate by 60% versus 30-40% for massage and passive recovery. They have also suggested that active recovery is the most effective method for blood lactate clearance in football players when compared with massage and passive recovery methods.

Recent studies have compared active versus passive recovery modalities and their effects on clearing accumulated blood lactate after intense exercise (Minahan et al., 2020; Sañudo et al., 2020; Solsona et al., 2021). While low to moderate-intensity active recovery does not appear to accelerate lactate removal kinetics compared to passive rest (Sañudo et al., 2020). It may enhance intramuscular lactate processing and glycogen resynthesis (Mohr et al., 2022). This suggests potential benefits for repeating

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high-intensity efforts. However, heavy active recovery can slow net blood lactate removal due to concurrent production and clearance (Dong et al., 2021). Another interesting recovery intervention such as cold water immersion can also accelerate blood lactate reduction pattern (Calleja-González et al., 2021). In professional women's football players, it was found that low-intensity active recovery can clear blood lactate faster than passive rest. However, it does not reduce muscle inflammation for up to 72 hours. Overall, the aforementioned studies indicate most post-exercise recovery techniques induce small-to-moderate effects on blood lactate removal kinetics (Minahan et al., 2020). Despite that, there is still debate regarding optimal recovery modes for lactate clearance versus endogenous muscle recovery processes (Altarriba-Bartes et al., 2021). More evidence is needed on longer-term effects on muscle function and training adaptations (Junior et al., 2024). Additionally, research concerning post-exercise lactate removal kinetics remains relatively inadequate, especially regarding adolescent team sport athletes. Youth might experience different metabolic effects due to their biological growth compared to adults (Krüger et al., 2020).

In particular, there are no published studies reported regarding lactate removal patterns among regional under-17 (U17) players in Tripura State. The post-exertion lactate recovery profile among footballers native to Tripura state can offer a meaningful idea for youth squad coaches in this region. Therefore, the purpose of the study was to find out the difference between the active and passive recovery modes in lactate removal in blood followed by an intensive activity. The findings of the study may give a better understanding of the player's recovery condition. This will also open a door for further studies with other physiological variables. Optimizing intermittent exercise performance and lactate clearance ability among the players will give significant scope for improved conditioning after the intensive training sessions (Plumb, 2024).

## 2. MATERIAL AND METHOD

### 2.1 The Participants

The participants of the study consisted of 10 boys under 17 national-level soccer players (age: 15.6±0.52 years, height:167.25±6.09 cm, weight: 53.45±4.07 kg) from Tripura State of India. All the participants were trained under the same program for the last 4 years at the State Sports School in Tripura. All the participants were informed about the experimental procedure and they all volunteered to take part in the study. The participants signed written consent for participation. The researcher obtained ethical permission from the ethical committee.

### 2.2 Test Protocol

The test was conducted in the morning session under controlled laboratory conditions. The participants were asked to refrain from training for 24 hours before each test day. Each participant performed a treadmill run at 90% intensity of their highest sprint speed. Immediately after the test, two modes of recovery (Active or Passive recovery) were facilitated on two separate days. The test was started with 40% of intensity. After every 2 minutes, the intensity was gradually increased by 10% till it reached its 80% level of intensity. Then they were instructed to run at 90% intensity for 5 minutes. The exercise session was separated by one week but, the exercise protocol remains the same on both days.

### 2.3 Recovery Protocol

In the Active Recovery mode, the participants were instructed to run for 5 minutes with 25% intensity on the treadmill immediately after the completion of a 5-minute run at 90% intensity.

In Passive Recovery, the participants rested on a yoga mat in the supine position for 5 minutes, immediately after the completion of 5 min run at 90% intensity and then sat quietly for 1 hour.

### 2.4 Blood Sampling

The blood samples were drawn immediately after the completion of a 5-minute run at 90% intensity. Then once again blood samples were taken after the facilitation of 5 min recovery mode. The blood samples were collected from the figure tips and analyzed by Lactate Pro 2 Blood Lactate Test Meter product of Arkray (Koka-Shi, Japan). Heart rate was measured continuously before, during, and after the test.

### 2.5 Statistical Analysis

The statistical analysis was conducted with the help of MS Office 2021. Paired t-test was used to compare blood lactate removal patterns during active and passive recovery and the level of significance was set at 0.05.

## 3. RESULT AND DISCUSSION

### 3.1 Result

In the following section results of the present study are discussed.

**Table 1.** Comparison of Rate of Lactate Removal During Active Recovery and Passive Recovery Mode

| Blood Sample Collection | Mode of Recovery | Number of Participants (N) | Amount of Blood lactate reduced (mmol/L) | Standard Deviation | Range (mmol/L) | p-value |
|---|---|---|---|---|---|---|
| Before and after the 5 minutes of facilitation of the recovery mode. | Active Recovery | 10 | 4.32 | 2.1 | 1.1-8.3 | 0.005* |
| | Passive Recovery | 10 | 2.27 | 1.11 | 0.5-4.4 | |
| After 10 minutes of completion of the recovery mode. (After 15 minutes of completion of exercise) | Active Recovery | 10 | 2.36 | 1.2 | 0.5-4.9 | 0.788 |
| | Passive Recovery | 10 | 2.55 | 1.35 | 0.3-4.7 | |

Table 1 shows lactate concentration changes during two post-exercise recovery phases for active and passive recovery modes. In phase 1, immediately after a 5-minute recovery period, active recovery resulted in greater lactate reduction with levels decreasing by 4.32 ± 2.1 mmol/L, versus 2.27 ± 1.11 mmol/L in passive mode. This difference of 2.05 mmol/L was statistically significant with a p-value of 0.005. However, in phase 2, measured 10 minutes after phase 1 sampling, both recovery methods showed further lowered lactate concentrations and the difference between active and passive groups was no longer significant (p=0.788). Active recovery decreased lactate to 2.36 ± 1.2 mmol/L while the passive method resulted in 2.55 ± 1.35 mmol/L lactate. In summary, there is an early significant benefit of active over passive recovery related to lactate removal rate immediately post-exercise, but this difference in rate becomes insignificant after 10 minutes of recovery. Both modalities showed continued lowering of lactate during the 10-minute monitored recovery period.

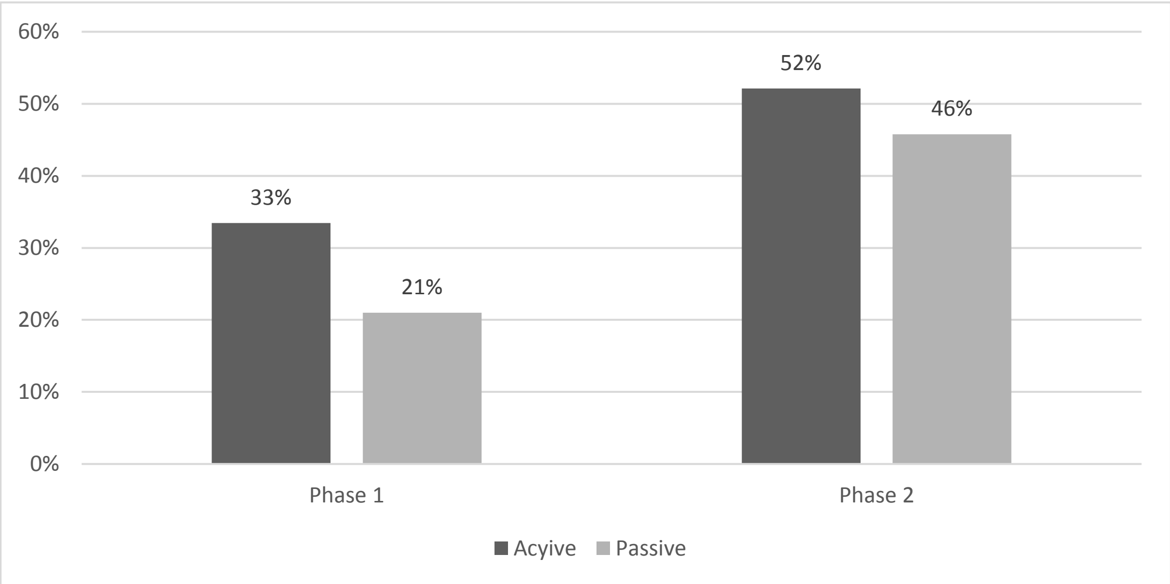


**Figure 1.** Lactate Concentration During Phase 1 and Phase 2 Blood Sample Collection

N.B. Phase 1: immediately after the 5-minute recovery mode is completed. Phase 2: 10 minutes after recovery mode facilitation

### 3.2 Discussion

The main purpose of the study was to compare the lactate removal rate after the facilitation of active recovery mode and passive recovery mode in football players. The study significantly indicated that there was a difference in lactate removal pattern after running intensity at 90% of the highest sprinting intensity. It was found that the rate of lactate removal was significantly higher (p=0.005) after 5 minutes of facilitation of active recovery mode. Additionally, the present study showed that 52% of lactate removal occurs after active recovery. Meanwhile, 46 % lactate reduction was observed after the passive mode recovery.

The significant difference between the two recovery modes indicates that the active recovery mode removes the blood lactate at a faster rate. This faster elimination of blood lactate during active recovery mode could be linked to improved blood circulation during that period. Sañudo et al. (2020) and his colleagues reported that active recovery shows a better blood circulation rate in the muscles. As a result, muscles get the required oxygen amount, which aids in removing the lactate concentration. Plumb (2024) also agreed that the active recovery mode has better blood circulation than the passive recovery but for a short period. Further, Çalışkan & Kızılet (2024) also confirm that these increases in blood circulation levels have a positive effect on lactate clearance.

The present study observed that after 5 min active recovery 52% of the lactate reduction was observed. A similar observation was also found in a study done on professional football players. The result of the study showed that active recovery cleared 50% of lactate accumulation after 15 minutes of recovery mode fasciculation (Çalışkan & Kızılet, 2024). Some studies on various events like running, cycling Cadenas-Sanchez et al. (2024), and swimming Xiao et al. (2023) reported resembling results to the current study. The mechanism discussed by Potočnik (2022) involves improving blood flow and the delivery of metabolic substances, which helps in sustaining vasodilation. This in turn allows active muscles to take up lactate through transporters, for immediate oxidation or gluconeogenesis (Brini et al., 2020). By following this process excess lactate produced during efforts can be effectively transported, buffered, and used during recovery activities.

During intense exercise, lactate builds up rapidly in the active muscles due to anaerobic glycolysis when the oxygen supply cannot keep up with demand (Schierbauer et al., 2023). This lactate must be cleared quickly post-exercise for muscles to recover and avoid fatigue. An efficient blood circulatory system is vital for shuttling lactate from muscles to sites of utilization and metabolism (Brooks, 2023). Once produced, lactate rapidly diffuses out of muscle cells into the interstitial fluid via "Mono-Carboxylate Transporters" or MCTs. Mono-carboxylate transporters (MCTs) play a crucial role in expelling lactate swiftly from muscle cells into the bloodstream (Dong et al., 2021). This function prevents harmful drops in the pH of skeletal muscles. MCTs such as MCT1 and MCT4 work together to export lactate. While MCT1 and MCT2 isoforms are expressed tissues such as cardiac muscle, brain, liver, and resting skeletal muscle oxidizes lactate present in the blood (Broskey et al., 2020). The increased muscle blood flow caused by vasodilation also aids the subsequent movement of lactate from interstitial spaces into the bloodstream (Dong et al., 2021). This allows lactate to circulate to tissues like the heart, brain, liver, kidneys, and less active skeletal muscles. In these oxidative tissues, lactate is taken up efficiently by cells via MCTs. This accounts for roughly 70% of disposed lactate during the post-exercise period (Broskey et al., 2020). Much of the remaining circulatory lactate (nearly 60%) is taken up by the liver and converted back into glucose via gluconeogenesis (Schierbauer et al., 2023). Further, this glucose may return to muscles to replenish glycogen stores. Some lactate also gets oxidized completely in liver tissues to yield ATPs. This unique multi-organ cell-cell lactate shuttle network, coordinated by MCTs, underlies the efficient systemic clearance and metabolism of lactate produced during activity.

## CONCLUSION

These findings substantiate that incorporating low-to-moderate physical activity into early recovery after demanding training and competition induces meaningful short-term lactate clearance benefits versus passive rest through 5–10 minutes. By shuttling lactate to active muscles for efficient oxidation under sustained demand and perfusion, active recovery provides metabolic recovery advantages following intense anaerobic work. However, inherent clearance rate limits soon constrain continued acceleration effects. More research should explore ideal active recovery durations following varying session types along with implications on subsequent performance to delineate practical applications.

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